

A textual note on Hipparchus *In Arat. et Eudox.* 1.3.5-12

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(This is an unpublished, informal writing-up dating from 2019 of a conjecture I thought of in the early 1990s (1991?) after reading A. C. Bowen and B. R. Goldstein, "Hipparchus' Treatment of Early Greek Astronomy: The Case of Eudoxus and the Length of Daytime," *Proceedings of the American Philosophical Society* 135.2, 1991, 233-254.)

Hipparchus *In Arat. et Eudox.* 1.3.5-12, ed. Manitius 26-28.

5 Πρῶτον μὲν οὖν ὁ Ἄρατος ἀγνοεῖν μοι δοκεῖ τὸ
ἐγκλίμα τοῦ κόσμου νομίζων ἐν τοῖς περὶ τὴν Ἑλλάδα
τόποις τοιοῦτον εἶναι, ὥστε τὴν μεγίστην ἡμέραν 6
λόγον ἔχειν πρὸς τὴν ἐλαχίστην τὸν αὐτόν, ὃν ἔχει τὰ
ε' πρὸς τὰ γ'. λέγει γὰρ ἐπὶ τοῦ θερινοῦ τροπικοῦ·
497 τοῦ μὲν, ὅσον τε μάλιστα, δι' ὀκτὼ μετροῦθέντος
πέντε μὲν ἔνδια στρέφεται καὶ ὑπέριστα γαίης, 123v
τὰ τρία δ' ἐν περάτῃ. 10

In the first place Aratus seems to me not to know the inclination of the cosmos, supposing that in the regions around Greece it is such that the greatest day has the same ratio to the least as 5 has to 3. For he says on the topic of the summer tropic (circle):

If it is measured out, so far as possible, into eight, five are turned in the sky and above the Earth, and three in the other extremity.

6 συμφωνεῖται δὴ, διότι ἐν μὲν τοῖς περὶ τὴν Ἑλλάδα
τόποις ὁ γνώμων λόγον ἔχει πρὸς τὴν ἰσημερινὴν
σκιάν, ὃν ἔχει τὰ δ' πρὸς τὰ γ'. ἐκεῖ δὲ τοίνυν ἡ
μεγίστη ἡμέρα ἐστὶν ὥρων ἰσημερινῶν ἰδ' καὶ τριῶν
ἐγγιστα πεμπτημορίων, τὸ δὲ ἕξαγμα τοῦ πόλου μοιρῶν 15 ;
7 λξ' ὡς ἐγγιστα. ὅπου δὲ ἡ μεγίστη ἡμέρα λόγον ἔχει
πρὸς τὴν ἐλαχίστην, ὃν ἔχει τὰ ε' πρὸς τὰ γ', ἐκεῖ ἡ
μὲν μεγίστη ἡμέρα ἐστὶν ὥρων ιε', τὸ δὲ ἕξαγμα τοῦ
πόλου μοιρῶν μα' ὡς ἐγγιστα. ὁῦλον τοίνυν ὅτι οὐ
δυνατὸν ἐν τοῖς περὶ τὴν Ἑλλάδα <τόποις> τὸν προ- 20
ειρημένον εἶναι λόγον τῆς μεγίστης ἡμέρας πρὸς τὴν
ἐλαχίστην, ἀλλὰ μᾶλλον ἐν τοῖς περὶ τὸν Ἑλλήσποντον
τόποις.

He is in accord that in the regions around Greece the gnomon has the ratio to its equinoctial shadow that 4 has to 3. But there, the greatest day is 14 equinoctial hours and approximately three fifths, and the elevation of the pole is approximately 37°. Where the greatest day has the ratio to the least that 5 has to 3, there the greatest day is 15 hours, and the elevation of the pole is approximately 41°. Obviously the aforesaid ratio of the greatest day to the least cannot subsist in the <regions> around Greece, but rather in those around the Hellespont.

8 *Καίτοι γε ὁ μὲν Ἄρατος οὐκ ἂν ἑαυτοῦ κρίσιν
περὶ τῶν τοιούτων προφερόμενος γέγραπεν, ἀλλὰ τῷ²⁵
Εὐδόξῳ καὶ περὶ τούτου κατακολουθήσας. εἰ δὲ καὶ
ἂν ἑαυτοῦ γέγραπεν, οὐ διασαφήσας, ἐν ποίοις <τόποις>
ἔστιν ἡ προειρημένη ἔγκλισις τοῦ κόσμου, τάχα ἂν
κατὰ γε τοῦτο διακρούοιτο τὸ ἔγκλημα. ὁ μὲντοι γε
Ἄτταλος ὁμολογουμένως ἡγνῶει λέγων ἐν τοῖς περὶ τὴν
Ἑλλάδα τόποις τὴν μεγίστην ἡμέραν πρὸς τὴν ἐλαχίστην
λόγον ἔχειν, ὃν <ἔχει> τὰ ε' πρὸς τὰ γ'. προεκθέμενος
γὰρ τὰ ἐπὶ τοῦ θερινοῦ τροπικοῦ ποιήματα, ἐπιφέρει
ταυτί· „διὰ δὲ τούτου φανερόν ποιεῖ, διότι τὴν ὅλην
„πραγματεῖαν ἐν τοῖς περὶ τὴν Ἑλλάδα τόποις πεποιήται·
„παρ' ἐκείνοις γὰρ ἔστιν ἡ μακροτάτη ἡμέρα πρὸς τὴν
„μικροτάτην νύκτα ὥς τὰ ε' πρὸς τὰ γ'.“ ἔτι δὲ*

But Aratus did not write an opinion concerning these things on his own authority, but he was also following Eudoxus about this. Even if he had written on his own authority, since he doesn't clarify in which <regions> the aforesaid inclination of the cosmos subsists, perhaps he might have evaded the charge. But Attalus by all consent is ignorant when he says that in the regions around Greece the greatest day has the ratio to the least that 5 <has> to 3. For he first sets out the verses on the summer tropic (circle), and supplements this: "He makes it evident through this that he has composed the entire treatise in the regions around Greece; for with them the longest day is to the smallest night as 5 to 3."

μᾶλλον θαυμάσειεν ἂν τις, πῶς ποτε οὐκ ἐπέστησε
 τοῦ Εὐδόξου ἐν τῷ ἑτέρῳ συντάγματι διαφόρως ἐκθε-¹⁰
 μένου καὶ γράφοντος, ὅτι τὸ ὑπὲρ γῆν τοῦ τροπικοῦ
 τμήμα πρὸς τὸ ὑπὸ γῆν λόγον ἔχει, ὃν <ἔχει> τὰ ιβ'
 πρὸς τὰ ξ', ὁμοίως δὲ τούτῳ καὶ τῶν περὶ Φίλιππον
 ἀναγραφόντων καὶ ἄλλων πλειόνων, πλὴν ὅτι συντε-
 τάχασι μὲν τὰς συνανατολάς τε καὶ συγκαταδύσεις¹⁵
 τῶν ἄστρον ὡς ἐν τοῖς περὶ τὴν Ἑλλάδα τόποις
 τετηρημένων, κατὰ δὲ τὸ ἔγκλημα τῶν τόπων τούτων
 διημαρτήκασι.

Παραπέμψαντες <οὖν> τοῦτο τὸ ἀγνόημα τὴν ὅλην
 αὐτῶν σύνταξιν ἐπεσκεψάμεθα πρὸς τὸν ἐν τῇ Ἑλλάδι²⁰
 ὀρίζοντα. οὐδὲ γὰρ φιλαλήθους, ἀλλὰ κενοσπούδου,
 τὸ κατὰ πάντα μαχόμενον τῇ διεψευσμένη ὑποθέσει
 ἐπιλαμβάνεσθαι αὐτῶν, κἂν τύχῃ συμφώνως λεγόμενα
 τοῖς ἐν τῇ Ἑλλάδι φαινομένοις. ὑποκεισθῶ δὲ ἡμῖν
 ὀρίζων πρὸς τὴν ἐπίσκεψιν ὁ ἐν Ἀθήναις, οὗ ἐστὶν ἡ²⁵
 μεγίστη ἡμέρα ὥρων ἰσημερινῶν ἰδ' καὶ τριῶν πεμπτη-
 μορίων, τὸ δὲ ἕξαρχμα τοῦ πόλου περὶ μοίρας λξ'.

3. ἐκθέμενος B. || 4. ἐπιφέρεται A edd. || 5. διὰ δὲ τοῦτο
 B ed. pr. || 13. τούτων A. || 14. πλὴν ὅτι συντετάχασι*] πλὴν
 ἐπισυντετ. vulg. (ἐπὶ συντετ. M.) || 16. ὡς om. B. || 17. ἔγκλημα A. ||

My version of lines 13-21:

ὁμοίως δὲ τούτῳ καὶ τῶν περὶ Φίλιππον ἀναγραφόντων καὶ ἄλλων πλειόνων. πλὴν ἐπεὶ
 συντετάχασι μὲν τὰς συνανατολάς τε καὶ συγκαταδύσεις τῶν ἄστρον ὡς ἐν τοῖς περὶ
 τὴν Ἑλλάδα τόποις τετηρημένων, κατὰ δὲ τὸ ἔγκλημα τῶν τόπων τούτων διημαρτήκασι,
 παραπέμψαντες τοῦτο τὸ ἀγνόημα τὴν ὅλην αὐτῶν σύνταξιν ἐπεσκεψάμεθα πρὸς τὸν ἐν
 τῇ Ἑλλάδι ὀρίζοντα.

For πλὴν ἐπεὶ cf. 2.2.24, Manitius 148 line 17. This was obviously the original text here too,
 transmitted with a trivial orthographical distortion in the manuscript tradition. Manitius
 emends the ἐπί (ἐπεὶ) to πλὴν and mispunctuates to join the clause to the preceding instead of
 the following sentence, because he supposes that the subject of συντετάχασι and διημαρτήκασι is
 Philippos et al. whereas it is surely Aratus et al. The insertion of οὖν is therefore also
 unnecessary. Neugebauer's suggested emendation of 12 to 11 is attractive, though not for the
 primary reason he gives, but rather because in the context Hipparchus must be talking about a
 ratio applicable to Greece and that is close to $14 \frac{3}{5} : 9 \frac{2}{5}$. $11 : 7 = 14 \frac{2}{3} : 9 \frac{1}{3}$, whereas $12 : 7 \approx$
 $15.16 : 8.84$ which is even more extreme than $5 : 3$. I also wouldn't see a ratio of $11 : 7$ as necessarily
 evidence of Babylonian influence. For any ratio $M : m$ between 1.553 and 1.583, i.e. between $M =$

14.6 and $M = 14.7$ (excellent for central mainland Greece), 11 : 7 is an optimal approximation as a ratio of small whole numbers.

One might wonder the more, how on Earth he failed to notice this, since in his other compilation Eudoxus sets it out differently and writes that the segment of the tropic (circle) above the Earth has the ratio to the (segment) below the Earth that 12 (11?) <has> to 7, and those around Philippos and many others have recorded similarly to him. But since they have composed the simultaneous risings and simultaneous settings of the asterisms as having been observed in the regions around Greece, but erred with respect to the inclination of these regions, we shall dismiss this ignorance and examine their entire composition in relation to the horizon in Greece.